

erol-asparagine agar in 21 days. This pigment, when formed in sufficient quantity, is pH sensitive, showing the same changes observed for reverse mycelium pigment.

Carbon utilization: D-Glucose, L-arabinose, D-xylose, *i*-inositol, D-mannitol, D-fructose, and rhamnose are utilized for growth. Utilization of raffinose is doubtful. No growth or only a trace of growth with sucrose.

*Streptomyces griseochromogenes* Fukunaga, Misato, Ishii, and Asakawa. Description: Fukunaga et al. (52). (See also, Nagatsu, Suzuki, and Seino [128] for comparison with other strains.) Type strain: Fukunaga strain 2A 327 (Fukunaga et al., 52) = ATCC 14511 (Lessel and Hatt 1970, 73). ISP 5499 from E. F. Lessel. ATCC. as ATCC 14511: ISP description by Group E-6.

Spore-chain morphology: Section *Spirales* (Fig. 113) to *Retinaculiaperti*. Open loops and hooks as well as well-developed spirals are common. Mature spore chains generally contain 10 to 50 spores per chain. This morphology is seen on yeast-malt agar, oatmeal agar, salts-starch agar, and glycerol-asparagine agar. Spore surface: Spiny (Fig. 114).

Color of colony: Aerial mass color in the Gray color series (2fe, medium gray, or 3ge, light grayish yellowish brown) on yeast-malt agar, oatmeal agar, salts-starch agar, and glycerol-asparagine agar; white aerial mycelium may also be seen on young cultures or on 21-day-old cultures on glycerol-asparagine agar.

Reverse side of colony: No distinctive pigments (grayish yellow to orange yellow on yeast-malt agar; grayish yellow to light olive brown or grayish greenish yellow on oatmeal agar, salts-starch agar, and glycerol-asparagine agar).

Color in medium: Melanoid pigments are formed in peptone-yeast-iron agar, tyrosine agar, and tryptone-yeast broth. No pigment is found in the medium in yeast-malt agar, oatmeal agar, salts-starch agar, or glycerol-asparagine agar.

Carbon utilization: D-Glucose, L-arabinose, D-xylose, *i*-inositol, D-mannitol, D-fructose, sucrose, and raffinose are utilized for growth. No growth or only a trace of growth with rhamnose.

*Streptomyces griseoluteus* Umezawa, Hayano, Maeda, Ogata, and Okami. Descriptions: Umezawa et al. (192, p. 111); Umezawa et al. (193, p. 34-40); Okami (136, p. 478-479). Type strain: NIHJ P-37 (136, 192, 193) = IMRU 3729 (Waksman, 206). ISP 5392 from S. A. Waksman as IMRU 3729. ISP description by Group D-11.

Spore-chain morphology: Section *Rectiflexibiles* (Fig. 115). Crooked or hooked spore chains may also be seen. Mature spore chains are generally short, sometimes with less than 10 spores per chain. This morphology is seen on yeast-malt

agar, oatmeal agar, salts-starch agar, and glycerol-asparagine agar. Spore surface: Smooth (Fig. 116).

Special morphological characteristics: One observer reports sclerotia-like bodies on the substrate mycelium of salts-starch agar and unusual morphology in the sporulating aerial mycelium (Fig. 117). Another observer reports short chains of conidia-like spores on the substrate hyphae on yeast-malt agar and salts-starch agar.

Color of colony: Aerial mass color in the Gray color series on yeast-malt agar, oatmeal agar, and salts-starch agar. Aerial mycelium may be poorly developed or absent on glycerol-asparagine agar.

Reverse side of colony: No distinctive pigments (pale or grayish yellow to yellowish brown or olive brown) on yeast-malt agar, oatmeal agar, and glycerol-asparagine agar. Yellow to yellow brown may or may not be modified with red (orange) on salts-starch agar. Reverse mycelium pigment on salts-starch agar is a pH indicator, changing from red or reddish brown to gray with the addition of 0.05 N NaOH.

Color in medium: Melanoid pigments are not formed in peptone-yeast-iron agar, tyrosine agar, or tryptone-yeast broth. Red to bluish gray pigment is found in the medium in salts-starch agar. This pigment may show the same change observed for reverse mycelium pigment with the addition of 0.05 N NaOH.

Carbon utilization: D-Glucose, L-arabinose, D-xylose, D-mannitol, and D-fructose are utilized for growth. No growth or only a trace of growth with *i*-inositol, rhamnose, sucrose, or raffinose.

*Streptomyces griseosporeus* Niida and Ogasawara. Description: Niida and Ogasawara (131); antibiotic production described by Kondo et al. (93). Type strain: Meiji Seika Kaisha B-793 (134). ISP 5562 from T. Niida, Meiji Seika Kaisha, as B-793 = MS-1104. ISP description by Group F-2.

Spore-chain morphology: Section *Retinaculiaperti*. Spore chains may be flexuous (Fig. 118a) or in imperfect spirals, hooks, and loops (Fig. 118b). Flexuous chains are common. Mature spore chains are moderately long with 10 to 50 or more spores per chain. This morphology is seen on yeast-malt agar, oatmeal agar, salts-starch agar, and glycerol-asparagine agar. Spore surface: Smooth (Fig. 119).

Color of colony: Aerial mass color in the Gray color series (2fe or e, moderate gray; 3fe, light brownish gray; or 5fe, light grayish reddish brown) on yeast-malt agar, oatmeal agar, salts-starch agar, and glycerol-asparagine agar.

Reverse side of colony: No distinctive pigments (pale or grayish yellow or sometimes light yellowish brown on yeast-malt agar, oatmeal agar, salts-starch agar, and glycerol-asparagine agar).

Color in medium: Melanoid pigments are

formed in peptone-yeast-iron agar, tyrosine agar, and tryptone-yeast broth. No pigment is found in the medium in yeast-malt agar, oatmeal agar, salts-starch agar, or glycerol-asparagine agar.

Carbon utilization: D-Glucose, L-arabinose, D-xylose, *i*-inositol, D-mannitol, D-fructose, rhamnose, sucrose, and raffinose are all utilized for growth.

*Streptovercillium griseovercillatum* (Shinobu and Shimada) Locci, Baldacci, and Petrolini Baldan. Descriptions: *Streptomyces griseovercillatus* Shinobu and Shimada 1962, 170-175 (170); *Streptovercillium griseovercillatum* (Shinobu and Shimada) Locci, Baldacci, and Petrolini Baldan 1969, 9-40 (116). Type strain: Shinobu and Shimada's strain 722 (170). ISP 5507 from Y. Shimada as strain 722. ISP description by Group E-1.

Spore-chain morphology: Section *Verticillati*, umbellate monovercillate (biverticillate) (Fig. 120). Mature spore chains are short with 3 to 10 or more spores per chain. This morphology is seen on yeast-malt agar, oatmeal agar, salts-starch agar, and glycerol-asparagine agar. Spore surface: Smooth (Fig. 121).

Color of colony: Aerial mass color in the Red color series (usually 4ec, grayish yellowish pink; sometimes 4ge, light grayish reddish brown; 4ie, light brown; or 3ca, pale orange-yellow) on yeast-malt agar, oatmeal agar, salts-starch agar, and glycerol-asparagine agar.

Reverse side of colony: Yellowish brown or orange yellow on yeast-malt agar; grayish yellowish pink to light olive brown on oatmeal agar; yellowish brown to strong brown on salts-starch agar; pale or grayish yellow on glycerol-asparagine agar. Reverse mycelium pigment is not a pH indicator.

Color in medium: Melanoid pigments are not formed in peptone-yeast-iron agar, tyrosine agar, or tryptone-yeast broth. No pigment is found in the medium in yeast-malt agar, oatmeal agar, salts-starch agar, or glycerol-asparagine agar.

Carbon utilization: D-Glucose and *i*-inositol are utilized for growth. Utilization of D-fructose is doubtful. No growth or only a trace of growth with L-arabinose, D-xylose, raffinose, sucrose, rhamnose, or D-mannitol.

*Streptomyces helveticus* (sic) (Krasil'nikov, Korenyako, and Nikitina) Pridham. Descriptions: *Actinomyces helveticus* Krasil'nikov, Korenyako, and Nikitina (103: p. 224, 227-228); *Streptomyces helveticus* (Krasil'nikov, Korenyako, and Nikitina) Pridham 1970, 18 (147). Type strain: INMI 1013B (Krasil'nikov et al., op. cit.) = ATCC 19841 (Pridham op. cit.). ISP 5431 from N. A. Krasil'nikov as 1013B. ISP description by Group D-11.

Spore-chain morphology: Section *Retinaculia-perti* to *Spirales* (Fig. 122a). Straight to flexuous spore chains may also be common, especially when short spore chains are produced (Fig. 122b). This morphology is seen on oatmeal agar, salts-starch agar, and glycerol-asparagine agar. Sporulating aerial mycelium may be poorly developed or absent on yeast-malt agar. Spore surface: Smooth (Fig. 123).

Color of colony: Aerial mass color probably in the Red color series (3ca, pale orange yellow, to 4ca, light yellowish pink) on oatmeal agar and salts-starch agar when optimum sporulation occurs. Aerial mass color may also appear to be white or yellow (2ba or 2db, pale yellow) on oatmeal agar and salts-starch agar. Aerial mycelium is poorly developed on yeast-malt agar and glycerol-asparagine agar.

Reverse side of colony: No distinctive pigment (light yellow or pale yellow) on yeast-malt agar, oatmeal agar, salts-starch agar, and glycerol-asparagine agar.

Color in medium: Melanoid pigments are not formed in peptone-yeast-iron agar, tyrosine agar, or tryptone-yeast broth. No pigment or only a trace of yellow is found in the medium in yeast-malt agar, oatmeal agar, salts-starch agar, and glycerol-asparagine agar.

Carbon utilization: D-Glucose, L-arabinose, D-xylose, and *i*-inositol are utilized for growth. Utilization of D-fructose is doubtful. No growth or only a trace of growth with rhamnose, sucrose, raffinose, or D-mannitol.

*Streptomyces horton* (sic) (Erikson) Pridham, Hesseltine, and Benedict. Descriptions: *Actinomyces horton* (sic) Erikson 1935, 36 (46); *Streptomyces horton* (sic) (Erikson) Pridham, Hesseltine, and Benedict 1958, 60 (148). Type strain: Erikson 600 (op. cit.) = NCTC 600 (D. M. Wibley, Macaulay Institute for Soil Research, personal communication, August 1964). ISP 5266 from NCTC as NCTC 600. ISP description by Group E-3.

Spore-chain morphology: Section not determined. This strain does not produce sporulating aerial mycelium on yeast-malt agar, oatmeal agar, salts-starch agar, glycerol-asparagine agar, or other media tested by ISP collaborators. Erikson's original paper (op. cit.) includes no description of aerial mycelium on any medium used in his study except the following comment: "Very sparse straight aerial mycelium produced only once on potato." Three ISP collaborators who studied this strain agree that it probably does not belong in the genus *Streptomyces*. Spore surface: Not determined.

Color of colony: Aerial mass color not determined. Aerial mycelium is not formed on



FIG. 115. *S. griseoluteus*. Short, crooked RF spore chains.  $\times 380$ . (a) Salts-starch agar, 17 days. (b) Waksman starch agar, 17 days.

FIG. 116. *S. griseoluteus*. Smooth spores; electron micrograph from 14-day-old culture on oatmeal agar.

FIG. 117. *S. griseoluteus*. Unusual aerial morphology; agar plug cover slip preparation.  $\times 150$ . (a, b) Salts-starch agar, 5 days. (c) Yeast-malt agar, 7 days.

FIG. 118. *S. griseosporeus*. RA morphology on glycerol-asparagine agar, 14 days.  $\times 800$ . (a) Straight to flexuous chains. (b) Hooks, loops, and primitive spirals.

FIG. 119. *S. griseosporeus*. Smooth spores; electron micrograph from 14-day-old culture on yeast-malt agar.